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PATENT
Serial No. 10/575,352

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	Richard E. Smalley *et al.*
Serial No:	10/575,352
Filing Date:	January 31, 2008
Group Art Unit:	1793
Confirmation No:	9439
Examiner Name:	Daniel McCracken
Title:	*Amplification of Carbon Nanotubes Via Seeded-Growth Methods*

Mail Stop: AMENDMENT
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

DECLARATION UNDER 37 CFR §1.132

We, James M. Tour and Robert H. Hauge, declare as follows:

1. We are over the age of 18 and fully competent to make this declaration. We have been informed that any false statements made in this declaration could affect the validity of any claims issuing from this application and subject us to possible punishment by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code.

2. We are inventors of the above-referenced application (US Application Serial No. 10/575,352, hereinafter "Application"). Therefore, We are familiar with the Application.

3. The claimed invention in the Application generally pertains to the bulk growth of carbon nanotubes (CNTs) of a single electronic type by the following general steps: (1) cutting a plurality of CNTs to provide cut CNTs; (2) sorting the cut CNTs by electronic type to provide sorted cut CNTs; (3) selectively docking at least one end of the sorted cut CNTs to metal catalyst precursors to form CNT seeds; and (4) growing the CNT seeds to form a

CNT product of increased length and a single electronic type. A key aspect of the claimed invention is the step of selectively docking at least one end of the sorted cut CNTs to metal catalyst precursors. Specifically, without such selective docking, CNT amplification of a single electronic type cannot occur.

4. Prior to the invention, no methods existed for producing large quantities of CNTs that had a precisely defined electronic type. Furthermore, the claimed invention provides an unmet need in producing bulk quantities of CNTs of a single electronic type for use in numerous electronic devices.

5. We are also familiar with the Examiner's rejection of the claims of the Application, as set forth in the Office Action mailed June 21, 2011 (hereinafter "Office Action").

6. For the reasons set forth below, We respectfully disagree with the Examiner's contention that the claimed invention is allegedly obvious in view of the cited references in the Office Action.

7. For instance, Margrave (U.S. Pat. App. Pub. No. 2002/0004028) remains silent on sorting cut CNTs by electronic type. Furthermore, Margrave does not teach or suggest any methods of selectively docking at least one end of the sorted cut CNTs to metal catalyst precursors to form CNT seeds. In contrast, Margrave's methods result in the general placement of metal catalyst precursors on multiple areas on the CNTs (including the CNT sidewalls), not selectively on the CNT ends. Specifically, Margrave discloses a process of covalently bonding chelating agents to the sidewalls of fluorinated carbon nanotubes by replacement reactions where chelating agents replace fluorine groups. *See, e.g.*, Paragraph 169.

8. Even though Margrave indicates that metal ions (such as Fe^{+3}) could migrate to CNT ends (*See, e.g.*, Paragraph 169), such a migration as disclosed in Margrave cannot lead to the selective docking of metal catalysts to the ends of CNTs. In contrast, the addition of metal ions to CNTs via chelating groups (as disclosed in Paragraph 169 of Margrave)

would lead to thermal defunctionalization and subsequent loss of the metal ions at higher temperatures (i.e., about 250 °C to 300 °C).

9. Moreover, even if the metal atoms disclosed in Margrave stayed on the CNT sidewalls, the metal atoms would not migrate to the ends of the CNTs. Instead, the metal atoms would degrade the CNTs. For instance, upon heat treatment, the iron atoms on the CNTs would catalytically react with the CNT sidewalls and expel small carbon species that would generate holes on the CNT sidewalls. This would in turn lead to the destruction of the CNTs.

10. Thus, in view of the aforementioned defects in Margrave, a reasonable expectation of success does not exist in Margrave for <u>selectively docking</u> at least one end of CNTs to metal catalyst precursors to form CNT seeds. As such, a reasonable expectation of success also does not exist in Margrave for <u>growing</u> CNT seeds to form a CNT product of <u>a single electronic type</u>. Rather, the absence of selective docking of metal catalysts to CNT ends in Margrave would prevent the amplification of any CNT products, including CNT products of <u>a single electronic type</u>.

11. Resasco (U.S. Pat. No. 6,413,487) also does not cure the aforementioned defects in Margrave. For instance, Resasco discloses methods and apparatus for catalytic production of carbon nanotubes. *See, e.g.*, Abstract. Yet, the disclosed methods and apparatus in Resasco do not teach or suggest any methods for sorting CNTs by <u>electronic type</u>, as required for the rejected claims. In fact, We are unaware of any disclosure in Resasco that even pertains to the sorting of the catalytically produced carbon nanotubes. Accordingly, Resasco also does not teach or suggest any methods of <u>growing</u> CNT seeds to form CNT products of <u>a single electronic type</u>.

12. The disclosure in Gu (Nano Letters, 2002, 2(9):1009-1013) is also defective with respect to the claimed invention. For instance, rather than disclosing methods for sorting CNTs by <u>electronic type</u>, Gu focuses exclusively on methods of "***Cutting*** Single-Wall Carbon Nanotubes through Fluorinaton." *See, e.g.*, Title and Abstract (emphasis added). Thus,

Gu also does not teach or suggest any methods of <u>growing</u> CNT seeds to form CNT products of <u>a single electronic type</u>.

13. An (Journal of American Chemical Society, 2002, 124(46):13688-13689) also does not cure the aforementioned defects in Gu, Resasco and Margrave. In particular, An focuses on a specific method of synthesizing uniform single-walled carbon nanotubes by utilizing metal-containing molecular nanoclusters as catalysts. *See, e.g.,* Title and page 13689 (col. 2). However, An remains entirely silent on any methods of sorting the synthesized carbon nanotubes, including sorting CNTs by <u>electronic type</u>. Accordingly, An also does not teach or suggest any methods of <u>growing</u> CNT seeds to form CNT products of <u>a single electronic type</u>.

14. The disclosure in Dillon (Applied Physics, 2001, 72:133-142) also does not cure the aforementioned defects in An, Gu, Resasco and Margrave. Rather, the disclosure in Dillon pertains to a summary of hydrogen storage methods that utilize carbon adsorbents. *See, e.g.,* Abstract of Dillon. Therefore, and not surprisingly, Dillon also remains entirely silent on any methods of sorting CNTs by <u>electronic type</u> or <u>growing</u> CNT seeds to form CNT product of <u>a single electronic type</u>.

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Date

James M. Tour

Date

Robert H. Hauge

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Date

James M. Tour

11/18/2011

Date

Robert H. Hauge